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14. Studies on the Effects of Water Vapour on Porcelain Enamel

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In summer, the season of high atmospheric humidity in Japan, most enamel shops encounter the sieges of blistering. In order to make clear of the cause of this defects the authors have investigated the reaction between water vapour and enameled steel.

A. Effects of water vapour during the firing. Although it is the general opinion that the furnace atmosphere has a great influence on blistering, the limit of the moisture content which causes the occurrence of blistering seems not to have been established. The specimens, applied with ground coat, single and double coat, were fired in an electric furnace, being injected by water vapour to adjust the moisture content so that their values would be 2, 4, 5, 9, and 90 % respectively. The results indicated that there exists the clear boundary at the moisture content of 3% by volume. The firing of the first and the second cover coat in a dry atmosphere has been found as insufficient to avoid the blistering if the ground coat had been fired in an atmosphere of the moisture content which exceeds the above limit. In the atmosphere of high humidity the blistering occurs more violently with the decreasing thickness of enamel.

B. Effects of water vapour on solidified enamel. Though water or its vapour is not able to diffuse through the solidified enamel layer, the reaction of water vapour with steel would occur if, by improper handling, the fine cracks were accidentary introduced in the enamel layer. To investigate the effects of such cracks the specimens, after being applied with the first cover coat, were quenched in water or mercury in order to introduce the fine cracks artificially. These cracks have also been formed by bending the specimens mechanically. Then the specimens were immersed in water for three hours or heated for an hour at 300°C in the atmosphere of high humidity to give sure contact of water vapour with steel. All specimens treated with the methods given above and applied with the second cover coat showed blistering after firing.

The following two methods have been suggested for avoiding blistering in the factory practice: 1) the replacement of the furnace gases by dry air from time to time is necessary in order to keep the water content below 3 per cent. 2) rough handling and sudden change of temperature, which will cause the occurrence of fine cracks, must be avoided in every steps of enameling process.